EXHIBIT DX7

TO DECLARATION OF PETER GOSS IN SUPPORT OF DEFENDANTS' OPPOSITION TO PLAINTIFFS' MOTION TO EXCLUDE THE OPINIONS AND TESTIMONY OF

JOHN ABRAHAM, PH.D.

UNITED STATES DISTRICT COURT

DISTRICT OF MINNESOTA

- - - - - - - - - - - - - - - - - -

In Re:

Bair Hugger Forced Air Warming

Products Liability Litigation

This Document Relates To:

All Actions MDL No. 15-2666 (JNE/FLM)

- - - - - - - - - - - - - - - - - -

DEPOSITION OF THOMAS H. KUEHN

VOLUME I, PAGES 1 - 351

JULY 10, 2017

(The following is the deposition of THOMAS H. KUEHN, taken pursuant to Notice of Taking Deposition, via videotape, at the offices of Ciresi Conlin L.L.P., 225 South 6th Street, Suite 4600, Minneapolis, Minnesota, commencing at approximately 9:25 o'clock a.m., July 10, 2017.)

flow and turbulent flow?
A. Yes.
Q. Do you hold yourself out as an expert between laminar flow and turbulent flow with respect to an operating room?
A. As applied to an operating room, probably not.
Q. Okay. Do you know whether or not you could get true laminar flow in an operating room?
A. I would suspect that would be highly unlikely.
Q. You don't hold yourself out as an expert in particle flow in an operating room; correct?
A. Not that I've worked in. I've never measured particle flows in an operating room, so I do not consider myself to be an expert.
Q. Are you able to calculate how turbulent flow affects particle movement in an operating room?
A. I -- I know how to do that in -- in general. I would assume it would be applied to airflow in an operating room also.
Q. Can you do that by hand, or do you need to use the Navier-Stokes equation?
THE REPORTER: "...do you need to use" --
Q. Can you do that by hand, or do you need to

use some sort of computational modeling?
A. For realistic applications that are fairly complex, you would need to use some software.
Q. Okay. Such as ANSYS?
A. Yes.
Q. Okay. And have you ever used ANSYS or any type of computer program to determine how particles move in a turbulent environment?
A. Yes.
Q. When?
A. I gave a short course for the American Association of Aerosol Research probably 20 years ago which included stochastic particle modeling, effect of turbulence, turbulent kinetic energy, and basically using Lagrange in particle tracking.
Q. And you agree with me that you have to use Lagrange in particle tracking to actually track particles in a turbulent environment; correct?
A. It turns out that if your particles are small enough and the airflow does not change direction very quickly, you could actually use a streamline, the time-average streamlines, and predict the most probable particle trajectory in a turbulent environment.
Q. And when you say "small enough," usually one

micron or less; correct?
A. Yes.
Q. Anything larger than one micron actually has inertia; correct?
A. As I said, it depends on the -- the direction-of-flow change. If there's no significant acceleration or direction-of-flow change, then you can actually use larger particles.
Q. Well how large?
A. Again, depends on the -- the direction-of-flow change.
Q. But you agree with me that even in a filter, that particles larger than one micron do not follow the -- the -- the airflow stream; correct?
A. Because of the -- the sharp transition of air -- air streamlines around the fibers of the filter material.
Q. And that's when you -- you -- you collect particles by impaction during -- for larger particles; correct?
A. That's correct.
Q. Because larger particles have inertia; correct?
A. Yes.
Q. If there's a -- if there's a change in the

direction of the air stream, it's no longer going to follow -- the particle is no longer going to follow the air stream, it has inertia and will get away from the air stream; correct?
A. And it depends on the ratio of the particle inertia and the -- the acceleration.
Q. And in fact, when you add turbulence to the equation, that also affects the airflow when the intensity of the turbulence increases; correct? Or particle movement.
A. Yes, it definitely affects particle movement.
Q. Okay. You could have a general air stream, but once you add turbulence to that air stream, you really can't use the -- the mean average with respect to particle movement any more because you have turbulence.
A. That would still be the most probable particle path. The turbulence dispersion would be about that streamline.
Q. Okay. Do you have any articles to support that opinion?
A. I'm -- I'm trying to think if -- if we published something like that back in the early 1990s, and I -- I'd have to go back and look at my

publication record.
Q. And there has been a lot of advancement in computational fluid dynamics software since the 1990s; hasn't there?
A. Yes.
Q. More-powerful computers; correct?
A. Yes.
Q. The technical limitation is actually the computer.
A. That's probably correct.
Q. Might be other limitations, but the most significant limitation in performing these calculations are the ability of computers to actually computate all the data.
A. It's -- it's the refinement of the grid essentially.
Q. When is the last time you constructed a grid for a CFD analysis?
A. Personally?
Q. Yes.
A. Probably -- it's been probably about 20 years ago.
Q. You've read Elghabashi's expert report; correct?
A. I have.

Q. Do you agree that Elghabashi is an expert in particle movement?
A. I would say he probably is, yes.
Q. Are you aware that --
You also looked at his deposition, correct, Dr. Elghabashi's deposition?
A. I -- I was given his deposition. I did not have a chance to read through it.
Q. Are you aware that he's doing work for the military with aircraft-carrier design?
A. I was not aware of that.
Q. Okay. Are you aware that he has access to the military supercomputer that most people don't have access to?
A. I was not aware of that.
Q. Are you aware of the military supercomputer that the military uses for aviation?
A. Not specifically, no.
Q. Are you familiar with the Navier-Stokes equation?
(Discussion off the stenographic record.)
A. Yes.
Q. If I asked you to write the equation out, could you do that today?
A. I could probably give it a good -- good

shot.
Q. So the answer to that would be maybe, but not -- you're not a hundred percent sure you could do it.
A. I -- I'm probably 90 percent sure I could do it.
Q. Could you write out the boussinesq approach with -- incorporating that into the Navier-Stokes equation today?
A. I could probably do that.
Q. Have you reviewed the videos of Dr. Elghabashi regarding his CFD analysis?
A. The videos, no.
Q. Did you ever consider doing your measurements with a PIV?
A. Which -- which measurements?
Q. The measurements you did for Exhibit B with a --
Do you know what a PIV is?
A. Yes.
Q. What's a PIV?
A. Particle Image Velocimetry.
Q. And that's the most accurate way to measure velocity of the air today; correct?
A. It's a non-intrusive method. It's also a

very expensive piece of equipment and requires a lot of data -- data analysis.
Q. Did you consider using that in your analysis?
A. No, because of the --
I wasn't sure I had avail -- that type of instrumentation available to me and how much effort it would require to set it up and -- and reduce the data.
Q. And it's very expensive.
A. And it's very expensive, yes.
Q. Could be in -- in -- in the millions.
A. I don't think it's quite that much, but certainly hundreds of thousands.
Q. Okay. Did you ever consider using ANSYS to model the Bair Hugger in an operating room?
A. I did not really consider that. I really have not done CFD work myself for -- for many years.
Q. But you consider yourself an expert in CFD.
A. I -- I know the protocol, the limitations, yes.
Q. What are the limitations?
A. Limitations are associated with time steps, with grid resolution, with the turbulent model that you use if you're using a turbulent model, surface conditions, any thermal bouyancy involved. And of

course particle modeling adds another way of complexity.
Q. Do you think you're capable sitting here today to perform a CFD analysis, without anyone else's help, on an operating room?
A. It would take me quite a while to go back and review the manual and get up -- up to speed. I could probably do it, but it would take me quite a while.
Q. So you'll agree with me that with respect to computational fluid dynamics in the present, you're not an expert in it as of right now.
A. In terms of actually personally performing the results, --
Q. Yes.
A. -- no.
Q. So you'll agree that you're not an expert at this point in time in your career.
A. In terms of analyzing other people's results, I think I am. In terms of generating my own results, no.
Q. Do you know the difference between a RANS model and an LES model? R-A-N-S and L-E-S.
A. It's been a long time since I've thought about that, but it's Reynolds Averaging Navier-Stokes

versus Large Eddy Simulation.
Q. When you performed CFD analysis, did you ever use LES?
A. I did not personally. It was the Reynolds Averaging.
Q. Okay. And -- and the purpose of the boussinesq and the RANS is to reduce the computational time when you use computational fluid dynamics; correct?
A. That's correct, using a simplified set of equations.
Q. Okay. When was the first time you saw a Bair Hugger?
A. Probably in the -- the office, maybe in March or April.
Q. Okay. And which Bair Hugger model was it?
A. I believe it was the -- we may have looked at both the 505 and the 750 or 755, or --
There was an earlier version and at least one of the later versions.
Q. Okay. Going -- going back, and I might have asked you this before, you haven't seen Abraham's report; correct?
A. I have not, yes.
Q. Okay. So you haven't seen whether or not he

used R -- RANS or LES or the type of turbulent modeling.
A. Having not seen his report, I have no idea.
Q. Would you agree that when you -- when you model an operating room and you have people in it as well as lights and the flow is not turbulent -- or the flow is turbulent, that you should have some sort of turbulent modeling in your CFD analysis?
A. It depends what your ultimate objective is.
Q. To follow particles.
A. As I said before, if the streamlines had not changed direction very rapidly and the particles are small enough, they would simply follow the time-average streamline without using a turbulence model.
Q. Okay. When you say they're not -- they don't change direction very rapidly, what would that mean? What does that mean to you?
A. I -- I go back to impactor technology where you're purposely trying to extract particles from the airflow by changing the direction very rapidly, and so it depends on the velocity of the particle and -- and the -- well basically the velocity of the particle heading towards the surface, so impaction technology.
Q. Are you saying the change of airflow like 90 degrees, or are you saying five degrees, three

degrees?
A. It -- it --
Really, it depends on the rate of change of airflow, the -- the acceleration I would -- I should say, perpendicular to the mean flow direction.
Q. And in analyzing --
And in determining whether or not to use a turbulent model in the CFD, how do you determine whether or not you should assume that the particles travel along the air streams or not?
A. Again, depends on whether your flow is essentially unidirectional or there's a lot of accelerations associated with it, and -- and the directional changes.
Q. Well you agree with me that when you have obstructions such as the patient, surgeon, table, lights, you're going to have significant changes in the airflow direction when the air hits that; correct?
A. Yes.
Q. Okay. Knowing what an operating room is, do you agree with me that you should have some sort of turbulence modeling in an operating room if you're going to have a -- a valid CFD analysis?
MR. GOSS: Objection.
A. I think that would be the most appropriate,